Transverse Beam Jitter Specification

The transverse jitter in the beam is specified by a change in betatron action. The effective emittance of the beam, for calculation of required damping rates, acceptance etc., is given simply by the sum of the beam emittance and the transverse jitter.

The transverse jitter appears as coherent betatron oscillations of a bunch. If we assume that the betatron action of the centroid is equal to the jitter ΔJ, then the local oscillation amplitude Δx_0 of the centroid (at a location in the beamline with beta function β) is given by:

$$\Delta x_0 = \sqrt{2\beta\,\Delta J} \tag{1}$$

For a gaussian distribution of particles within the bunch, the rms beam size σ_x is given by (assuming zero dispersion):

$$\sigma_x = \sqrt{\beta\varepsilon_{rms}} \tag{2}$$

where ε_{rms} is the rms emittance of the beam. Thus,

$$\frac{\Delta x_0}{\sigma_x} = \sqrt{\frac{2\Delta J}{\varepsilon_{rms}}} \tag{3}$$

or, in terms of normalized quantities:

$$\frac{\Delta x_0}{\sigma_x} = \sqrt{\frac{2\Delta\gamma J}{\gamma\varepsilon_{rms}}} \tag{4}$$

For a flat distribution, we can replace the rms values by the edge values – the edge emittance is the maximum betatron action of any particle in the beam. In either case, a jitter equal to half the emittance corresponds to an oscillation amplitude equal to the beam size.